

WMP-SME-515



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By: Jnp ~

Date: 2/8/02

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Jenoe Tihanyi  
Applic. No. : 10/007,397  
Filed : October 22, 2001  
Title : Semiconductor Component

P R E L I M I N A R Y A M E N D M E N T

Hon. Commissioner of Patents and Trademarks,  
Washington, D. C. 20231

S i r :

Preliminary to examination, kindly amend the above-identified application as follows:

In the Translated Specification:

On page 1, line 1 through page 2, line 14, replace the paragraphs with:

-- SEMICONDUCTOR COMPONENT

Background of the Invention:

Field of the Invention:

The present invention relates to a semiconductor component, in particular a field-effect-controllable transistor.

DE 198 28 191 C1 discloses a lateral high-voltage transistor having, on an n-conducting substrate, an epitaxial layer in which source and drain zones and also a channel zone surrounding the source zone are formed. Trenches are provided in the epitaxial layer. The sidewalls of these trenches are heavily doped with a complementary dopant with respect to the rest of the epitaxial layer. A conductive channel in the channel zone can be controlled by means of a gate electrode insulated from the channel zone.

When a source-drain voltage is applied, a space charge zone propagates in this transistor - if no gate-source voltage is applied - proceeding from the source zone, and as the voltage rises, the space charge zone gradually reaches the complementarily doped sidewalls of the trenches in the direction of the drain zone. Where the space charge zone propagates, free charge carriers of the doped sidewalls of the trenches and free charge carriers of the surrounding epitaxial layer mutually compensate one another. In these regions in which the free charge carriers mutually compensate one another, a high breakdown voltage results for lack of free charge carriers. The reverse voltage of the transistor can be

set by means of the doping of the trenches, the epitaxial layer preferably being highly doped, as a result of which the transistor has a low on resistance when the gate is driven.

Such transistors having a low on resistance but a high reverse voltage are currently available only as discrete components, that is to say only the transistor is realized in a semiconductor body. However, for many applications, for example for switching loads, it is desirable to integrate a transistor as a switching element and its associated drive circuit, for example using CMOS technology, in a single semiconductor body.

Summary of the Invention: --

On page 5, line 27 through page 6, line 28, replace the paragraphs with:

-- Brief Description of the Drawings:

Fig. 1 is a cross sectional view of a first exemplary embodiment of a semiconductor component;

Fig. 2 is a plan view of an embodiment of a semiconductor component with elongate first terminal zones;

Fig. 3 is a plan view of an embodiment of a semiconductor component with an annularly closed first terminal zone;

Fig. 4 is a cross sectional view of another exemplary embodiment of a semiconductor component;

Fig. 5 is a cross sectional view of another exemplary embodiment of a semiconductor component with a plurality of first terminal zones and compensation zones running in a pillar-shaped manner;

Fig. 6 is a cross sectional view of another exemplary embodiment of a semiconductor component with a plurality of first terminal zones and compensation zones of spherical design;

Fig. 7 is a cross sectional view of another exemplary embodiment of a semiconductor component with a plurality of first terminal zones and with first compensation zones adjacent second compensation zones; and

Fig. 8 is a cross sectional view of another exemplary embodiment of a semiconductor component with a plurality of first terminal zones and with a second terminal zone surrounding the first terminal zones in a well-like manner.

Description of the Preferred Embodiments: --

On page 8, lines 23-30, replace the paragraph with:

--P-doped compensation zones 30 are formed in the n-doped layer 24, and in the exemplary embodiment shown in figure 1, the compensation zones extend in a pillar-shaped manner in the vertical direction of the semiconductor body 20. The cross section of these pillars 30 is circular in the exemplary embodiments shown in figures 2 and 3, but this cross section can assume virtually any other geometric shape and can be, for example, rectangular, square or octagonal. --

On page 18, delete all of the material on that page.

On page 19, line 1, change "Patent Claims" to:

-- I claim: --

After page 21, add the following page:

-- ABSTRACT OF THE DISCLOSURE:

A semiconductor component includes a semiconductor body having a substrate of a first conduction type and a first layer of a second conduction type that is located above the substrate. A channel zone of the first conduction type is formed in the

first layer. A first terminal zone of the second conduction type is configured adjacent the channel zone. A second terminal zone of the first conduction type is formed in the first layer. Compensation zones of the first conduction type are formed in the first layer. A second layer of the second conduction type is configured between the substrate and the compensation zones. --

In the Claims:

Please cancel claims 1-14 and please add the following new claims:

-- 15. A semiconductor component, comprising:

a semiconductor body having a substrate of a first conduction type and a first layer of a second conduction type located above said substrate;

a channel zone of said first conduction type formed in said first layer;

a first terminal zone of said second conduction type configured adjacent said channel zone;

a second terminal zone of said first conduction type formed in said first layer;

compensation zones of said first conduction type formed in said first layer; and

a second layer of said second conduction type configured between said substrate and said compensation zones.

16. The semiconductor component according to claim 15, comprising:

a boundary zone of said first conduction type extending vertically in said first layer towards said semiconductor body.

17. The semiconductor component according to claim 16, wherein said boundary zone extends from said channel zone to said substrate.

18. The semiconductor component according to claim 16, wherein said boundary zone is laterally spaced away from said channel zone.

19. The semiconductor component according to claim 18, wherein:

said semiconductor body has a first surface; and

said boundary zone extends from said first surface of said semiconductor body to said substrate.

20. The semiconductor component according to claim 15, wherein said compensation zones have a pillar-shaped design.

21. The semiconductor component according to claim 20, wherein at least some of said compensation zones adjoin said channel zone.

22. The semiconductor component according to claim 15, wherein said compensation zones have a spherical design.

23. The semiconductor component according to claim 15, wherein:

said compensation zones define first compensation zones;

said first layer has second compensation zones of said second conduction type formed therein;

said second compensation zones are adjacent said first compensation zones; and



said second compensation zones are doped more heavily than said second layer.

24. The semiconductor component according to claim 15, wherein said boundary zone is doped more heavily than said substrate.

25. The semiconductor component according to claim 15, wherein:

said second terminal zone has a first section extending vertically to said second layer; and

said second layer laterally extends at a level;

said second terminal zone has a second section extending laterally at said level of said second layer.

26. The semiconductor component according to claim 25, wherein said first section and said second section of said second terminal zone form a well-like structure enclosing said first terminal zone and at least some of said compensation zones.

27. The semiconductor component according to claim 15, wherein:

said second terminal zone has a first section extending vertically to said second layer; and

said second terminal zone has a second section extending laterally near said second layer.

28. The semiconductor component according to claim 27, wherein said first section and said second section of said second terminal zone form a well-like structure enclosing said first terminal zone and at least some of said compensation zones.

29. The semiconductor component according to claim 15, wherein said first layer has a number of dopant atoms of said first conduction type and a number of dopant atoms of said second conduction type that are approximately identical.

30. A semiconductor component, comprising:

a semiconductor body having a substrate of a first conduction type and a first layer of a second conduction type located above said substrate;

a second layer of said second conduction type formed between said first layer and said substrate, said second layer being doped more weakly than said first layer; and

a boundary zone of said first conduction type, said boundary zone vertically extending to said substrate and to said second layer. --

Remarks:

The preliminary amendment is being filed in an effort to present an application in proper U.S. format and to present claims in proper U.S. claim idiom for examination.

The newly entered claims are fully supported in the originally presented claims and in the claims of the German priority application.

An early action on the merits of the claims is requested.

Respectfully submitted,

Mark P. Weichselbaum  
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For Applicant

MPW:cgm

February 8, 2002

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P R E L I M I N A R Y A M E N D M E N T

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Translated Specification:

On page 1, line 1 through page 2, line 14:

[Description

Semiconductor component] SEMICONDUCTOR COMPONENTBackground of the Invention:Field of the Invention:

The present invention relates to a semiconductor component, in particular a field-effect-controllable transistor.

DE 198 28 191 C1 discloses a lateral high-voltage transistor having, on an n-conducting substrate, an epitaxial layer in which source and drain zones and also a channel zone

surrounding the source zone are formed. Trenches are provided in the epitaxial layer. [, the sidewalls of which] The sidewalls of these trenches are heavily doped with a complementary dopant with respect to the rest of the epitaxial layer. A conductive channel in the channel zone can be controlled by means of a gate electrode insulated from the channel zone.

When a source-drain voltage is applied, a space charge zone propagates in this transistor - if no gate-source voltage is applied - proceeding from the source zone, and[, ] as the voltage rises, the space charge zone gradually reaches the complementarily doped sidewalls of the trenches in the direction of the drain zone. Where the space charge zone propagates, free charge carriers of the doped sidewalls of the trenches and free charge carriers of the surrounding epitaxial layer mutually compensate one another. In these regions in which the free charge carriers mutually compensate one another, a high breakdown voltage results for lack of free charge carriers. The reverse voltage of the transistor can be set by means of the doping of the trenches, the epitaxial layer preferably being highly doped, as a result of which the transistor has a low on resistance when the gate is driven.

Such transistors having a low on resistance but a high reverse voltage are currently available only as discrete components,

that is to say only the transistor is realized in a semiconductor body. However, for many applications, for example for switching loads, it is desirable to integrate a transistor as a switching element and its associated drive circuit, for example using CMOS technology, in a single semiconductor body.

[This goal is achieved by means of a semiconductor component in accordance with the features of claim 1.

The subclaims relate to advantageous refinements of the invention.]

Summary of the Invention:

On page 5, line 27 through page 6, line 28:

[The present invention is explained in more detail below using exemplary embodiments with reference to figures, in which:

figure 1 shows a first exemplary embodiment of a semiconductor component according to the invention in a lateral sectional illustration;

figure 2 shows a semiconductor component according to the invention according to an embodiment with elongate first terminal zones in a sectional illustration in plan view;

figure 3 shows a semiconductor component according to the invention with an annularly closed first terminal zone in a lateral sectional illustration in plan view;

figure 4 shows a semiconductor component according to the invention according to a further embodiment of the invention in a lateral sectional illustration;

figure 5 shows a semiconductor component with a plurality of first terminal zones and compensation zones running in a pillar-shaped manner in a lateral sectional illustration;

figure 6 shows a semiconductor component with a plurality of first terminal zones and compensation zones of spherical design in a lateral sectional illustration;

figure 7 shows a semiconductor component with a plurality of first terminal zones and first and second compensation zones arranged adjacent in a lateral sectional illustration; and

figure 8 shows a semiconductor component according to the invention with a plurality of first terminal zones and a second terminal zone surrounding the first terminal zones in a well-like manner, in a lateral sectional illustration.]



Brief Description of the Drawings:

Fig. 1 is a cross sectional view of a first exemplary embodiment of a semiconductor component;

Fig. 2 is a plan view of an embodiment of a semiconductor component with elongate first terminal zones;

Fig. 3 is a plan view of an embodiment of a semiconductor component with an annularly closed first terminal zone;

Fig. 4 is a cross sectional view of another exemplary embodiment of a semiconductor component;

Fig. 5 is a cross sectional view of another exemplary embodiment of a semiconductor component with a plurality of first terminal zones and compensation zones running in a pillar-shaped manner;

Fig. 6 is a cross sectional view of another exemplary embodiment of a semiconductor component with a plurality of first terminal zones and compensation zones of spherical design;

Fig. 7 is a cross sectional view of another exemplary embodiment of a semiconductor component with a plurality of

first terminal zones and with first compensation zones  
adjacent second compensation zones; and

Fig. 8 is a cross sectional view of another exemplary  
embodiment of a semiconductor component with a plurality of  
first terminal zones and with a second terminal zone  
surrounding the first terminal zones in a well-like manner.

Description of the Preferred Embodiments:

On page 8, lines 23-30:

[p-doped] P-doped compensation zones 30 are formed in the n-doped layer 24, and[,] in the exemplary embodiment [according to] shown in figure 1, the compensation zones extend in a pillar-shaped manner in the vertical direction of the semiconductor body 20. The cross section of these pillars 30 is circular in the exemplary embodiments [according to] shown in figures 2 and 3, but this cross section can assume virtually any other geometric [shapes] shape and can be, for example, rectangular, square or octagonal.

On page 18:

[List of reference symbols

20

Semiconductor body

22	Substrate
24	First n-conducting layer
26	Second n-conducting layer
30, 30A	Compensation zone
32	p-conducting layer
40	Source zone
50, 50A, 50B, 50C	Channel zone
52	Source electrode
60	Drain zone
62	Drain electrode
70	Gate electrode
70A, 70B, 70C, 70D	Gate electrodes
72	Insulation layer
72A, 72B, 72C, 72D	Insulation layers
80	Boundary zone
90	Metalization layer
90, 91, 92, 93, 94	Field plates
95	Field plate
124	n-conducting layer
126	n-conducting layer
201	First surface of the semiconductor
body	
T1, T2	CMOS transistors
S	Source terminal
G	Gate terminal
D	Drain terminal

+U <sub>D</sub>	Drain potential
n	n-doped zone
p	p-doped zone]

On page 19, line 1, [Patent Claims] I claim:

After page 21:

-- ABSTRACT OF THE DISCLOSURE:

A semiconductor component includes a semiconductor body having a substrate of a first conduction type and a first layer of a second conduction type that is located above the substrate. A channel zone of the first conduction type is formed in the first layer. A first terminal zone of the second conduction type is configured adjacent the channel zone. A second terminal zone of the first conduction type is formed in the first layer. Compensation zones of the first conduction type are formed in the first layer. A second layer of the second conduction type is configured between the substrate and the compensation zones.

Docket No.: WMP-SME 515

CERTIFICATION

I, the below named translator, hereby declare that: my name and post office address are as stated below; that I am knowledgeable in the English and German languages, and that I believe that the attached text is a true and complete translation of the application filed on October 22, 2001 under Application No. 10/007,397.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

HOLLYWOOD, FLORIDA

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Christine Kahl

February 8, 2002

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